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Habitat selection of the Wood mouse (*Apodemus sylvaticus*) in cereal steppes of Central Spain

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Abstract

Studied the distributional patterns of *Apodemus sylvaticus* in an area dominated by cornfield cultivations. Seven habitat variables measured at 44 sampling stations were related to the corresponding summer and winter indexes of mouse abundance by means of multiple regression analysis. In summer, no relationships between habitat features and mouse abundance were obtained. Instead, winter abundance was positively related with shrublands and negatively correlated with grasslands and cultivated fields. This regression model was tested on 68 new sampling stations; predicted and observed values were significatively correlated, thus validating the result. The observed winter distribution patterns are discussed in the light of the thermoregulatory behaviour of mice.

Introduction

The Wood mouse (*Apodemus sylvaticus* L., 1758) is one of the most ubiquitous and abundant small mammals in the Western Palaearctic (Corbet and Southern 1977). Despite its forest origin, it also inhabits cultivated areas, where it can become one of the more abundant small mammal species (Pelikan and Nesvasbova 1979; Angelstam et al. 1987; etc.).

This paper analyses the seasonal distribution of *A. sylvaticus* in Central Iberian cornfields, relating its abundance with some environmental factors and checking the temporal constancy of these relationships.

Study area

The study area is located in the middle of the Iberian Peninsula (41° 13′–41° 18′ N, 3° 44′–3° 48′ W), 1000 m a.s.l. The area belongs to the supramediterranean bioclimatic stage (Ozenda et al. 1979), the climate of which is characterized by hot, dry summers and cold winters (August and January mean temperatures of 20 and 1 °C, respectively, 610 mm annual rainfall; Ministerio de Agricultura 1987). Three main types of substrates are distributed in this open, patchy landscape: 1. shrublands occupying uncultivated areas with thin soil and frequent rocky outcrops, located on the drier slopes and with a vegetation composed of sparse, small bushes (around 20 cm high) of *Thymus zygis, Genista hispanica* and *Astragalus granatensis*; 2. grasslands installed on well-developed soils located in small, wet valleys interspersed with cultivated plots; and 3. cornfields, dedicated mainly to barley, wheat, rye and oat crops. A network of paths and some isolated bushes (*Rosa canina, Crataegus monogyna*) complete the landscape of this man-made steppe (see Tellería et al. 1988 for thorough descriptions of the study area).

Material and methods

An empirical model was established by use of regression analysis (James and McCulloch 1985), which requires obtaining the relative densities of mice in several plots in which habitat features can be measured, so that the abundance of mice (dependent variable) can be finally expressed as a function of some (independent) habitat variables. The model should then be tested by predicting mouse

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abundance in a second selection of plots in which habitat variables had previously been recorded. If predicted and observed values (i.e., actual results of trapping in the second selection) showed similar patterns, the validity of the model proposed would be confirmed (e.g. MORRISON et al. 1987).

In the first round, snap traps baited with cotton wicks steeped in rancid oil were placed in 44 sampling stations. Each sampling station consisted of five capture plots (three snap traps each) located at the corners and in the middle of a 15 m-side square. These capture plots were kept open for two consecutive days and checked daily during December–January, 1984–85, and July–August, 1985 (1320 traps × day each period). In the second round, 68 pitfall traps were set in different locations of the same study area. Each pitfall trap was taken as the equivalent of a first round sampling station and was kept open for 49 days in summer (July–August, 1985) and 35 days in winter (January–February, 1986). Pitfall traps were checked weekly.

To evaluate the habitat features, we defined a 1 ha circular surface area (56 m radius) around each first round sampling station (DUESER and SHUGART 1978) and evaluated by visual estimation (see PRODON 1976; AUGUST 1983) the cover of shrublands, grasslands and cultivated fields; cover of other landscape components such as paths, stones and bushes, that could influence the distribution of the species (HEALING 1980; PARMENTER et al. 1983) was also evaluated. The same variables were considered in the second round, although measured over a smaller area (0.2 ha, 25 m radius around each pitfall trap). Further details on the variables employed can be found in Table 1.

To avoid incidence of zero values, the sampling stations of both rounds were grouped in pairs on the basis of their overall habitat similarity. This provided 22 and 34 analytical units for the first and second rounds, respectively. A stepwise multiple regression equation was used to predict the abundance of Wood mice within the first round (snap traps) data set. The number of captures was included as the dependent variable, and the habitat attributes were used as independent variables. Habitat variables were log-transformed (ZAR 1984). A correlation matrix among all variables allowed us to pair the variables and to remove the ones highly correlated with other easiest to measure and/or with more biological meaning (see YAHNER 1983; MAURER 1986; MORRISON et al. 1987; for similar methodological approaches). Thus, the cover of shrubs lower than 0.5 m and the cover of rocks (Tab. 1) were removed because of their significant correlations with the covers of shrublands ($r = 0.58$, $p < 0.01$) and paths ($r = 0.56$, $p < 0.01$), respectively.

Table 1. **Description of the habitat variables measured**

Variables	Descriptions
Substrates	
1. Grass	Percentage cover of grasslands in a circular surface area (1 ha for first round and 0.2 ha for second), centered around the sampling station.
2. Shrubl	Same as (1) for shrublands.
3. Cult	Same as (1) for cultivated fields.
Structural components	
4. Path	Proportion (in %) in a circular surface area (1 ha for first round and 0.2 ha for second round), centered around the sampling station, ocuppied by paths or country roads.
5. Rock	Same as (4) for stone piles; usually they are extracted as a consequence of farming works.
6. SHR–1	Proportion (in %) in a circular surface area (1 ha for first round and 0.2 for second round), centered around the sampling station, covered with shrubs < 0.5 m in height.
7. SHR–2	Same as (6) for shrubs with height > 0.5 and < 2 m.

Results

During the first and second rounds we caught, respectively, 102 (59 in winter and 43 in summer) and 121 (37 in winter and 84 in summer) mice. The numbers of winter snap-trapped mice were negatively correlated (simple correlation) with the cover of grasslands and positively related with the cover of shrublands. In summer, however, no significant correlation was obtained (Tab. 2). Similar correlation patterns were attained from the

Table 2. **Simple correlations among winter and summer abundance of mice and habitat variables** (see Table 1 for abbreviations)

Mouse abundance	Grass	Shrubl	Cult	Path	SHR-2
First round (n=22)					
Winter	−0.456*	0.540**	−0.310	−0.304	0.233
Summer	−0.106	0.098	0.161	−0.132	0.077
Second round (n=34)					
Winter	−0.382*	0.280	−0.380*	0.163	−0.157
Summer	0.048	0.213	0.099	0.153	0.205

* $p < 0.05$; ** $p < 0.01$.

second round set of data in which mouse distribution was negatively related with the more open substrata (Tab. 2).

No stepwise multiple regression model was obtained with the summer results of the first round, whereas winter mouse abundance was related to grassland and shrubland cover according to the equation Mouse abundance = 2.16 − 1.18 · Grass + 1.54 · Shrubl. (R^2 = 0.32, n = 23, $P < 0.01$). We checked the validity of this regression model by comparing its predictions with the actual results of the pitfall data set. As both sets of data were obtained by different trapping procedures, we used a simple correlation analysis to test the degree of association of the abundance distributional patterns. The correlation obtained was significant (r = 0.353, n = 34, $P < 0.01$ one-tailed), thus confirming the similarity of predicted and observed trends of abundance values and the constancy of the effects of the above-mentioned habitat cues (grasslands and shrublands) on the winter distribution of mice in the study area.

Discussion

Despite the well-known interannual variability of density in small mammal populations (e.g., Krebs et al. 1973; Churchfield 1980; Flowerdew 1985; Montgomery 1989a, b), and the different effectiveness of the two trapping methods employed (Tellería et al. 1987), in our study area there was a clear interannual constancy in the winter distributional patterns of Wood mice (e.g., avoidance of pastures and cultivated fields vs. occupation of shrublands).

The relationship between Wood mouse abundance and shrub cover, which has been previously illustrated by several authors (Abramsky 1981; Boitani et al. 1985), can probably be extended to other epigeous small mammal species occasionally entering agricultural, open areas (Rowe and Swinney 1977; Pelikan and Nesvadbova 1979; Ryszkowski 1982; Yahner 1982, 1983). Nevertheless, Wood mice in cereal steppes of Central Spain were clearly seasonal in their response to this habitat feature. In summer, mice seemed to be scattered throughout the landscape, and their abundance was not associated with any habitat variable, whereas in winter they appeared to concentrate in shrublands, avoiding the open substrata (grasslands and cultivated lands; see Tellería et al. 1991). This winter pattern has been related to the thermal homeostasis of the species, which is obliged to build wintering nests in order to prevent lethal heat loss (see West and Dublin 1984). Shrublands were located in dry slopes and offered a high cover of shrubs that provided good nesting opportunities, whereas the wet grasslands and ploughed fields did not seem to facilitate this nesting behaviour. Similar trends have been observed in this and other small mammal species (Kikkawa 1964; Bergstedt 1966; Green 1979; Pelikan and Nesvadbova 1979; Yahner 1982, 1983; Montgomery 1985; Angelstam et al. 1987;

Dickman and Doncaster 1989; Tellería et al. 1991). In winter, these species avoid open, cultivated areas and tend to refuge in closed (bushed or wooded), stable areas (woodlots, shelterbelts, farms, etc.). Our results, showing the importance of shrubland patches as wintering grounds for this species, are consistent with Hansson's (1979) viewpoint that different units in patchy landscapes usually have complementary roles for the survival of vertebrates along the annual cycle.

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Zusammenfassung

Habitatwahl von Waldmäusen (Apodemus sylvaticus) in Getreidesteppen Zentralspaniens

In einer Getreideanbau-Region Zentralspaniens wurden relative Abundanzen von Waldmäusen in drei verschiedenen Habitaten (Getreideäcker, Wiesen, Buschland) in jeweils einer Sommer- und Winterperiode ermittelt. Sieben Habitatvariable wurden an 44 Fangstationen aufgenommen und mittels multipler Regressionsanalyse mit den korrespondierenden Abundanzen verglichen. Für die Sommerfänge ließ sich keine gesicherte Beziehung mit einer der Habitatvariablen feststellen, aber die Winterfänge waren positiv mit Buschland und negativ mit Wiesen und Äckern korreliert. Das Resultat wurde in einer zweiten Runde an 68 neuen Fangstationen überprüft und bestätigt; vorausgesagte und empirisch ermittelte Abundanzwerte waren signifikant korreliert. Der winterliche Rückzug der Waldmäuse von Feldern und Wiesen in Buschland wird im Hinblick auf das thermoregulatorische Verhalten diskutiert.

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